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HEAT-RELATED ILLNESSES AMONG WORKERS IN LATEX GLOVE INDUSTRY UNDER HEAT STRESS CONDITION

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By

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Thesis Submitted to the School of Graduate Studies, Universiti Putra Malaysia, in Fulfilment of the Requirements for the Degree of Master of Science

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Malaysia is the world largest producer of latex glove. Glove production involved work processes with high temperature. However, less study has been conducted on the hazards of high temperature among the workers here. Thus, this study was conducted to evaluate the heat-related illnesses and physiological changes among latex glove industry workers under heat stress condition. This cross-sectional study was conducted in a glove factory at Negeri Sembilan. This location was selected based on the highest number of workers in Negeri Sembilan which are 350 workers and the highest daily production rate. The respondents were randomly selected from the list name provided. Total workers (n=88) were interviewed using questionnaire adopted from previous study. The adopted questionnaire includes the socio demographic, occupational, lifestyle, health and heat-related illnesses information of respondents. Heat stress assessment (WBGTin) and the level of air velocity were measured using QUESTTemp°34 Thermal Environment Monitor and TSI Velocicalc®Air Velocity Meters respectively. The Personal heat monitor was used to monitor the level of personal body temperature of workers. Omron MC-510 Gentle Temperature ear thermometer (measure core body temperature), POLAR Heart Rate FT60 (measure heart rate) and OMRON T3 Automatic Blood Pressure Monitor (measure blood pressure) were used in the physiological changes measurement of the workers. All of these psychological parameters were taken in three sessions; before the shift, after 2 hours working and after 8 hours working. The result were exceeded Threshold Limit Value (TLV) (>28^{o}C) in the production area. The highest prevalence of heat-related illnesses on respondents was dehydration (81.8%), followed by heat exhaustion (80.7%), heat cramps (26.1%), heat rashes (26.1%), heat stroke (9.1%) and the heat syncope (6.8%). Based on this study there is a statistically significant correlation between personal heat and prevalence of heat-related illnesses ($r=0.54$, $p<0.05$). The chi-square test results revealed that only duration of employment ($X^2=3.475$, $p<0.01$) are significantly associated with prevalence of heat-related illnesses reported. the multivariate logistic regression shows that only the personal heat had a significant association with prevalence of heat-related illnesses. The prevalence of heat-related illnesses was measured using the questionnaire. The ANOVA was statistically significant between physiological parameter (core body temperature $F= 281.10$, $P<0.001$); heart rate, ($F=237.86$, $p<0.001$); and blood pressure, ($F= 194.43$, $p<0.001$) and three work session. As a conclusion, the workers in glove industry are exposed to high level of heat stress. All the three physiological parameters (core temperature, heart rate and blood pressure) of respondent data show that there were changed through three periods of time. The air velocity at majority work sections in production area was exceeded the baseline given for the specify temperature. The highest prevalence of heat-related illness on respondents was dehydration, followed by heat exhaustion, heat cramps, heat rashes and heat stroke. This shows that the glove industry expose workers to heat stress which directly causing workers to get heat-related illness. Personal protective equipment such as cool vest also helps in protection from hot working environment. The training on heat stress in the way of control heat stress should be provided by employers which help in educating and create awareness among workers on the symptoms of heat-related illness

Abstrak tesis yang dikemukakan kepada Senat Universiti Putra Malaysia sebagai memenuhi keperluan untuk ijazah Master Sains

PENYAKIT BERKAITAN HABA DALAM KALANGAN PEKERJA KILANG SARUNG TANGAN LATEKS DIBAWAH TEKANAN HABA

Oleh

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Malaysia merupakan pengeluar terbesar dunia bagi sarung tangan lateks. Pengeluaran sarung tangan melibatkan proses kerja dengan suhu yang tinggi. Namun, masih kurang kajian dilakukan berkenaan bahaya bekerja dalam keaadaan suhu yang tinggi dalam kalangan pekerja di sini. Tujuan kajian ini dijalankan adalah untuk menilai penyakit berkaitan haba dan perubahan fisiologi dalam kalangan pekerja kilang sarung tangan lateks dibawah tekanan haba. Kajian keratan rentas ini telah dijalankan di sebuah kilang sarung tangan di Negeri sembilan. Lokasi kajian ini dipilih berdasarkan kilang yang mempunyai jumlah pekerja yang tertinggi iaitu 350 pekerja dan kadar produksi yang tertinggi di Negeri Sembilan. Pekerja dipilih sejara rambang daripada senarai nama pekerja. Jumlah pekerja (n=88) telah ditemuramah mengunakan borang soal selidik kajian yang diadaptasi daripada kajian lepas yang disesuaikan dengan kajian semasa. Borang soal selidik tersebut merangkumi maklumat demografi sosio, pekerjaan, gaya hidup, kesihatan dan penyakit berkaitan haba. Penilaian tekanan haba (WBGTin) dan tahap halaju udara diukur dengan menggunakan pemantau suhu persekitaran (QUESTTemp°34) dan pengukur halaju udara (TSI Velocicalc®). Pengukur suhu peribadi digunakan untuk mengukur suhu badan pekerja secara peribadi. Omron MC-510 (mengukur teras suhu badan), POLAR FT60 (mengukur kadar denyutan nadi) dan OMRON T3 (mengukur tekanan darah) telah digunakan bagi mngukur perubahan fisiologi pekerja. Semua parameter ini telah diambil sebanyak tiga sesi iaitu sebelum syif, selepas 2 jam bekerja, dan selepas 8 jam bekerja. Keputusan membuktikan bahawa suhu persekitaran di semua bahagian kerja dalam kilang sarung tangan telah melebihi Nilai Had Ambang (TLV) (>28^{o}C). Prevalens paling tinggi bagi penyakit berkaitan haba adalah dehidrasi (81.8%), diikuti oleh keletihan haba (80.7%), kekejangan haba (26.1%), ruam panas (26.1%), strok haba (9.1 %) dan pengsan haba (6.8%). Terdapat perbezaan yang signifikan dalam parameter fisiologi (suhu badan teras, F= 281.10, P<0.001); kadar denyutan nadi, (F=237.86, p<0.001); dan

tekanan darah, (F= 194.43, p<0.001). Konklusinya, pekerja-pekerja di kilang sarung tangan telah terdedah kepada suhu yang sangat tinggi. Semua parameter fisiologi (teras suhu badan, kadar denyutan nadi dan tekanan darah) responden mempunyai perbezaan yang signifikan di antara tiga ukuran masa. Halaju bagi kebanyakan bahagian kerja di kawasan pengeluar adalah tinggi dari garispanduan yang ditetapkan bagi kadar suhu persekitaran kilang tersebut. Prevelens paling tinggi bagi penyakit berkaitan haba adalah dehidrasi, diikuti oleh keletihan haba, kekejangan haba, ruam panas, strok haba dan pengsan haba. Hal ini menunjukan kilang sarung tangan getah mededahkan pekerja dengan tekanan haba dan secara langsung menyebabkan pekerja mengalami penyakit berkenaan haba. Alat perlindungan personal seperti jaket sejuk dapat membantu dalam melindungi pekerja daripada persekitaran kerja yang panas. Selain itu, latihan berkenaan tegasan haba dalam mengawal tegasan haba perlu disediakan kepada pekerja bagi memberi pengetahuan dan kesedaran kepada pekerja tentang gejala penyakit berkenaan tegasan haba. Hal ini boleh membantu dalam menghalang kes tegasan haba daripada menjadi lebih teruk.

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This thesis was submitted to the Senate of Universiti Putra Malaysia and has been accepted as fulfilment of the requirement for the degree of Master of Science. The members of the Supervisory Committee were as follows:

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LIST OF ABBREVIATIONS

AAP	American Academy of Pediatrics
ACGIH	American Conference of Governmental Industrial Hygienists
BMI	Body Mass Index
bpm	beats per minute
DOSH	Department of Occupational Safety and Health
ILO	International Labor Organisation
m/s	meter per second
mmHG	milimeter per mercury
MREPC	Malaysia Rubber Export Promotion Council
NIOSH	National Institute for Occupational Safety and Health
NWSWFO	National Weather Service Weather Forcast Office
OSHA	Occupational Safety and Health Administration
SOCSO	Social Security Organisation
TLV	Threshold Limit Value
WBGTin	Wet Bulb Globe Temperature indoor
WHO	World Health Organisation

CHAPTER 1

INTRODUCTION

1.1 Background

Malaysia is the world's sixth largest producer of natural rubber with export of RM12.0 billion in 2010 and RM15.2 billion in 2014 (Malaysian Rubber Export Promotion Council, 2015). The latex products are the largest contributor to Malaysian exports of rubber products of RM12.2 billion in 2014 (MREPC, 2015). Since Malaysia is the largest producer of glove, there are high numbers of glove's factories develop in order to meet the export demand (MREPC, 2015). All this manufacturing processes have high production processes that involve a large number of workers with long duration of working. Most of the glove production is nonstop production with twenty-four hour process daily (MREPC, 2015).

In glove industry, most workers were exposed to high temperature due to the ovens (between 100^{o}C to 125^{o}C) in glove production area (Akaben, 2016). The production of glove involved burning and drying process by using ovens (Akaben, 2016). An Industry which using a furnace in their process such as oven can be a major contributor to heat stress, which also knew as a radiant heat source (Kishor et al., 2012). Thus, by using the oven at production area, workers in the glove production area are exposed to high level of heat.

The previous study proved that the heat stress in palm oil manufacturing can be affected by high temperature working environment which can affect the physiological changes of blood pressure, heart rate and body core temperature, and lead to heat-related illnesses (Athirah, 2014). Since, the production of glove involving high temperature process, the physiological parameter of the workers may be affected and may lead to heat-related illnesses. According to the study the external environmental factors that contributed to the heat stress among workers in hot working areas where temperature, humidity, radiant heat and air velocity (Ahasan, 2001). Thus, the air velocity and humidity also be measured in this study as an environmental factor that may contribute to high level of heat exposure to workers.

Heat stress related to occupation is one of the major problems affecting the health status of workers, especially in tropical countries such as Malaysia (Tawatsupa et al., 2010). Workers working in high temperature conditions must ensure constant core body temperature for his body to function well. To maintain a stable temperature, body needs to release heat to the surrounding environment at the same rate as heat is produced (Andrew, 2011). Heat stress will occur if body failed to control internal temperature (Guideline, 2016).

Besides, In glove production the process involving high level of heat production around 800, 000 kcal/hour of heat production (Top Glove, 2011).

1.2 Problem Statement

The study of heat stress among the workers has been commonly conducted and published. However, there was lack of study has been conducted in Malaysia, particularly among the gloves production workers. Most studies conducted on heat stress among workers in various workplaces where shown significant effect between high environmental temperature and negatively impact the worker's performance, attitude and satisfaction level. This includes the effect on the workers physiological parameter and may lead to heat-related illness. Azlis (2007) stated that there are many industries in Malaysia that have high potential involving heat stress to their employees. Exposure to high temperature can contribute to heat stress but to see the mechanism industry must play a big role in monitoring the heat emits by industry and the health status of workers that expose to high level of heat. Since glove industry mainly process using oven, there must be high risk of heat stress to workers. Oven as a source of burning process can contribute to physical hazard to workers such as injury when workers accidently touch the hot surface and heat-related illnesses when workers expose to heat emitted from the oven (Akaben, 2016). Besides, Malaysia also have a high potential of heat stress due to our hot whether as a tropical countries (Twatsupa et al., 2010). Previous study have made on heat stress in palm oil and steel industry in Malaysia but the study does not measure the personal heat of the workers compare to this study.

Glove industry is one of the biggest manufacturing industries in Malaysia (MARGMA, 2018). The top three glove maker in Malaysian are Top Glove Corp Bhd, Hartalega Holding Bhd and Kossan Rubber Industries Bhd (MARGMA, 2018). Malaysia rubber industry exports over 195 countries worldwide and is expected to increase from 232.2 billion gloves in 2017 to 286 billion gloves in 2018 (MARGMA, 2018). According to Malaysian Rubber Glove Manufacturers Association (MARGMA) the rubber gloves industry has grown tremendously throughout the past two decades and continues to display resilient growth (MARGMA, 2018). This tremendously growth of rubber industry leads to increasing of production rates and workforce to meet the global demand of rubber glove.

The production rate of glove industry is about 368, 640 pcs/hour with 24 hour of operation hour (MARGMA, 2018). The workers involve to archive the production rate are 350 workers for 12 line of production for two shift of work hour. The process flow of latex glove start from former cleaning, coagulant dipping, drying, latex dipping, leaching, beading, vulcanization, post leaching, slurry dipping, stripping, tumbling, quality-control and packing (Top glove, 2011). The process of drying, leaching, vulcanization and post leaching are involving workers to expose with high temperature of environment. The burning and drying process involve ovens which temperature around 100°C to 125°C (Akaben, 2016). This shows that the glove production area involve high temperature process. Thus, this research is needed to determine the heat stress index and metabolic workload at gloves production area.

The current interventions the glove industry applies are installation of drinking station, conduct heat stress awareness talk, and provide yearly medical surveillance and job rotation (Top Glove, 2011). Currently there is no research has be done on the heat exposure on the workers particularly working near oven. Thus, this study will determine the personal heat exposure of heat on workers near the oven area.

In 2012, there is a case at steel manufacturing plant, where a worker in furnace section fainted and being diagnosed with heat stroke (SOCSO, 2016). Now the worker is suffering with slurred speech and generalized body tremor. Other than that, there were another three cases reported in year 2013 and 2014 due to heat related illness which cause multiorgan failure (SOCSO, 2016). This shows that working near to furnace or oven can lead to heat-related illness. This study is conducted to study the prevalence of heat-related illness of the glove industry workers that exposed to the oven at production area.

Besides, the previous study proved that the heat stress at palm oil manufacturing industry can be affected by high temperature working environment which can affect the physiological changes of blood pressure, heart rate and body core temperature, and lead to heat-related illnesses (Athirah, 2014).Thus, this study was conducted to evaluate the heart rate, blood pressure, body core temperature change and heat related illness among Gloves Industry workers under heat stress at Negeri Sembilan. According to the previous study, external environmental factors that contribute to the heat stress among workers in hot working areas were temperature, humidity, radiant heat and air velocity (Ahasan, 2001).

The figure 1.1 showed that when the glove production worker exposed to high level of heat, the physiological parameters such as, blood pressure, heart rate and body core temperature tend to increase. When workers exposed to heat stress sourcing from oven, it can lead to physiological changes and causing heat –related illness to workers as shown in diagram below.

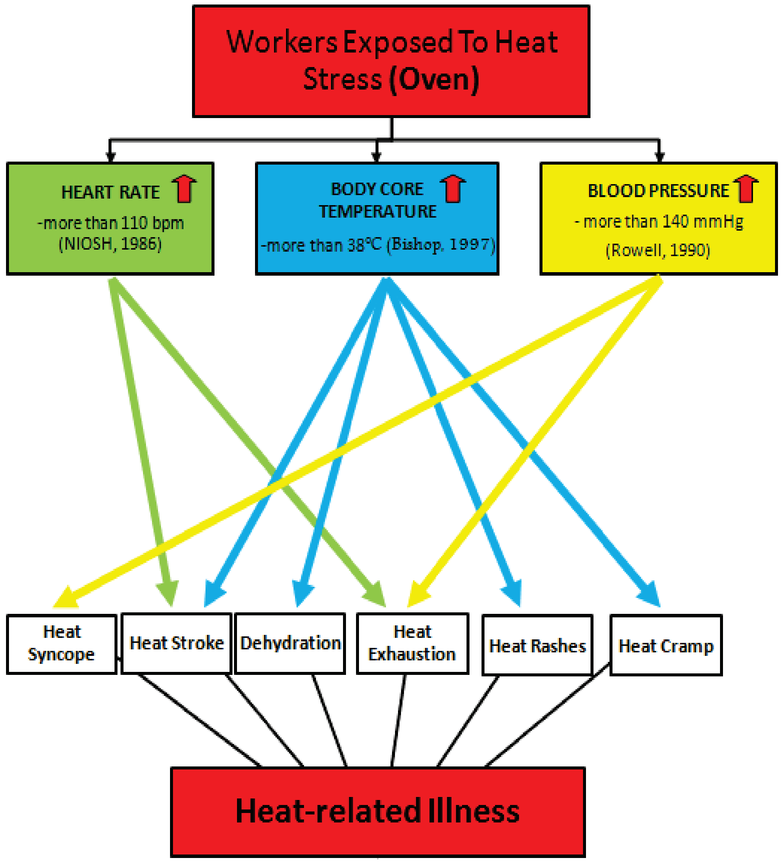

Figure 1.1: The relationship between the workers exposed to oven and the heat-related illness.

1.3 Study Justification

This study was conducted to develop data onto the level of heat stress at the glove industry in Malaysia. There are data recorded on heat stress cases by SOCSO, but the data not focused by specific type industry. So, there are no specific data of heat stress cases among glove industry workers. In addition, this study also be conducted to fulfill the research gap on this particular heat stress issue among manufacturing workers. Thus, this study was conducted to measure the heat stress and the effect on physiology (body core temperature, heart rate, blood pressure) and heat related illness to workers who are exposed to high temperature at glove industry. Besides, this study also focuses on the relationship between the personal heat and the WBGTin level which will help to show the effect of the heat stress directly to changes on personal heat of workers.

In addition, this study can provide baseline data onto heat stress in the glove industry. Since Malaysia already have our first guideline on heat stress by DOSH, this data and information about this study can also contribute as additional data.

1.4 Research Objectives

1.4.1 General objective

To study the heart rate, blood pressure, body core temperature change and heat related illnesses among workers in Gloves Industry under heat stress at Negeri Sembilan.

1.4.2 Specific objectives

The specific objectives of this study were as follow:

1. To determine socio-demographic data of respondent.
2. To determine the heat stress index and metabolic workload at gloves production area.
3. To determine the air velocity and relative humidity at gloves production area.
4. To determine the correlation between prevalence of heat-related illnesses and personal heat of worker that exposed to heat in glove production area.
5. To determine the association between socio-demographic and heat-related illnesses.
6. To determine the risk factors associated with heat-related illnesses among glove industry workers.
7. To determine the prevalence of heat related illnesses among worker.
8. To determine heart rate, blood pressure, body core temperature change between before shift, after 2 hours working and after 8 hours working among respondents.
9. To compare the differences of blood pressure, heart rate and body core temperature before shift, after 2 hours working, and after 8 hours working among workers exposed to heat.

1.5 Study Hypothesis

H_1: There is significant correlation between prevalence of heat-related illness and personal heat in glove Industry.

H_2: There is association between socio-demographic and prevalence of heat-related illnesses.

H_3: There is a significant association between associated risk factors with prevalence of heat related illness.

H_4: There is a significant difference in blood pressure, heart rate and body core temperature between before working, after 2 hours working, and after 8 hours working among workers exposed to heat.

1.6 Definition of Term

1.6.1 Heat stress

Conceptual Definition

Heat stress is a combination of heat load in individual and environmental factor impose on workers' bodies which give effect to workers' performance, safety and health. (Rasoul Hemmatjo et al., 2013).

Operational Definition

Heat stress level determined by using Questemp°34 Thermal Environmental Monitor to measure environmental temperature in degree Celsius by placing the instrument at 1.1 meters from the floor level where the heat stress is maximum.

1.6.2 Physiological Change

Conceptual Definition

Physiological change is physiological adaptations when the body tend to increase the temperature, heart rate, and blood pressure when expose to the high level of temperature (Barbara & Patricia, 2002).

Operational Definition

Body core temperature of workers measured by using Omron MC-510 Gentle Temperature Ear Thermometer in unit of degree Celsius and OMRON Blood Pressure Monitor Model T3 used to measure blood pressure in unit of millimeter mercury. While heart rate, it measured by using Polar Heart Rate Monitor Watch in unit of beat per minutes. All the parameter measure within three work session, which are before work, after two hour working and after eight hour working to see the physiological changes.

1.6.3 Heat-Related Illnesses

Conceptual Definition

Heat-related illnesses are a illness with symptoms including headache, nausea, and fatigue after exposure to the heat (MedicineNet.com, 2013). It is a set of preventable conditions ranging from mild forms such as heat exhaustion and heat cramps to potentially fatal heat stroke (Jonathan et al., 2011).

Operational Definition

Heat-related illness measured by using questionnaire adopted from previous study. The questionnaire consists of all symptoms related with heat effect after exposure to high level of temperature. The symptom categorise to the type of heat-related illness which are heat exhaustion, dehydration, heat syncope, heat rashes, and heat stroke.

1.6.4 Natural Wet Bulb Temperature

Conceptual Definition

Natural wet bulb temperature is which the air is allowed to flow over the sensor naturally rather than being forced. When air flow is less than 3 m/s (meter per second), the temperature reduce for the same absolute humidity and air movement (Barbara & Patricia, 2002).

Operational Definition

Wet bulb temperature is the temperature measured by using thermometer with sensor that covered by wetted cotton wick and exposed only to the natural air movement (NIOSH, 1986).

1.6.5 Globe Bulb Temperature

Conceptual Definition

Globe temperature responds to radiant heat from the solid surroundings and convective heat with the ambient air. It is used to estimate the average wall temperature of the surrounding (Barbara&Patricia, 2002).

Operational Definition

The globe temperature measured by using sixth inch, thin-walled, coppers sphere, painted matte black on the outside. The temperature sensor is placed at the center of the globe (Barbara&Patricia, 2002).

1.6.6 Dry Bulb Temperature

Conceptual Definition

Dry bulb temperature is the direct measure of air temperature. The temperature sensor is surrounded by air, which is allowed to freely flow around the sensor (Barbara&Patricia, 2002).

Operational Definition

Dry bulb temperature measured by using a thermal sensor that is shielded from direct radiant energy sources (U.S. Department of Labor, 1999).

1.7 Conceptual Framework

Workers are mainly exposed to five types of hazard. Heat stress is one of the main hazards in production of gloves. Workers in production areas were exposed to high temperature which caused physiological effect. In this conceptual framework the source of heat is a main oven. Heat stress can cause when there is combination of environmental factor and individual activity. The variable that concerned is environment variables which are humidity, air velocity, air temperature and radiant temperature. While for individual activity, consist of metabolic rates and workload.

Workers that exposed to high level of heat during work will tend to get heat stress which lead to physiological effect and heat related illness (Athirah, 2014). The body core temperature, heart rate and blood pressure of workers will increase when exposed to high level of heat (Athirah, 2014). Meanwhile, for heat-related illness it involved heat cramps, heat stroke, heat syncope and heat exhaustion.

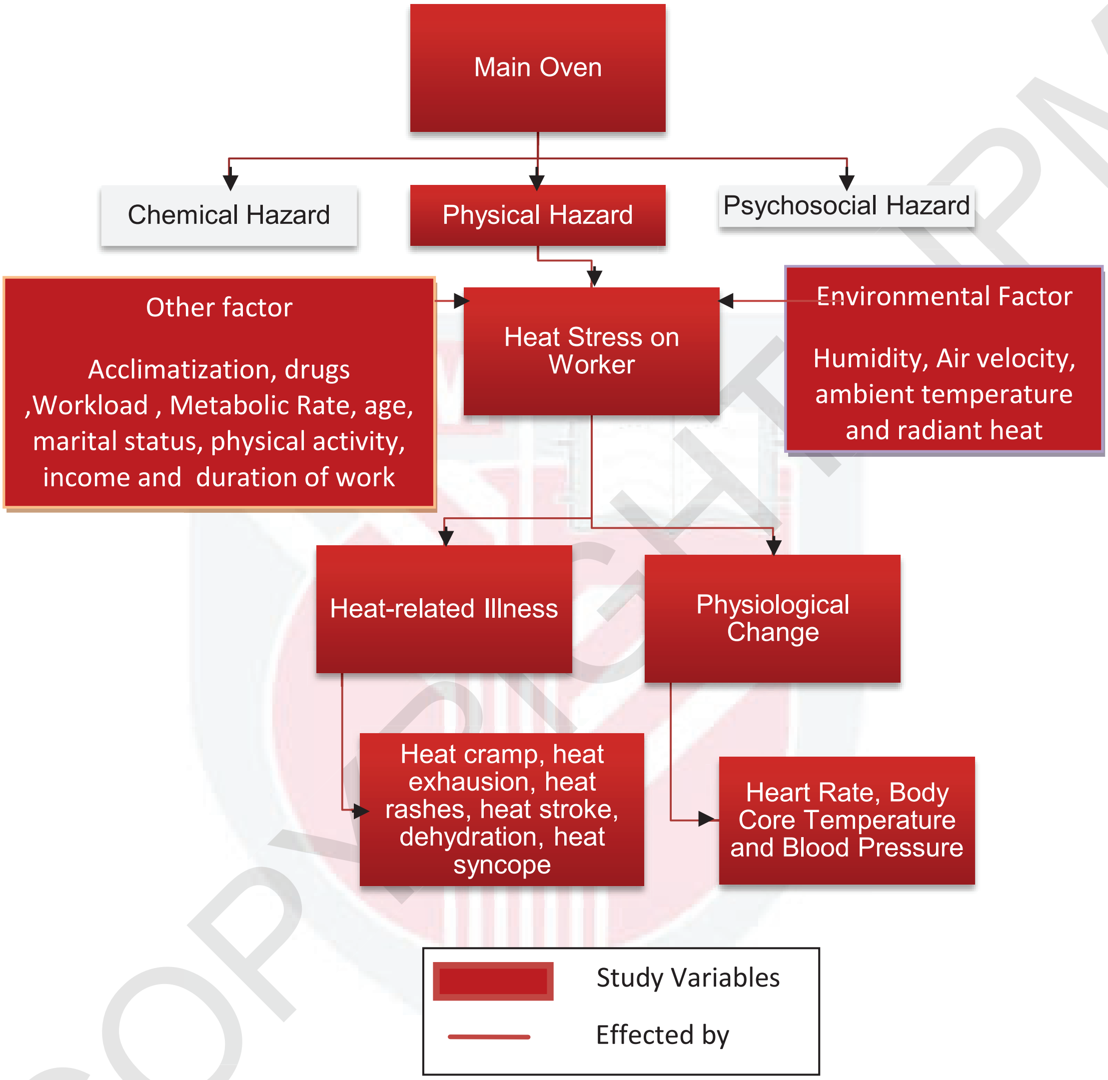

Figure 1.2: Conceptual Framework

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